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Ecological Landscape Design

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“Choose only one master-Nature”

Rembrandt Harmenszoon van Rijn (1606-1669)

1. Introduction

The most critical changes in the world over the last century have been derived from the variety of environmental problems. Growing environmental problems now affect entire the world. The majority of environmental problems originates in human greed and interference.

It is well known that planet Earth is experiencing a so-called environmental crisis (ecological crisis). This crisis is characterized by three major themes:

- Rapid growth of the human population and its associated economic activity,
- The depletion of both non-renewable and renewable resources, and
- Extensive and intensive damage caused to ecosystems and biodiversity.

The environmental crisis is a predicament of inappropriate design-it is a consequence of how cities have been developed, industrialization undertaken, and ecoscapes used. Fundamentally, the problem has been one of inadequate integration of ecological concerns into planning (Shu-Yang et al., 2004).

In many ways, the environmental crisis is a design crisis. It is clear that design has not been given a rich enough context. Design is a hinge that inevitably connects culture and nature through exchanges of materials, flow of energy, and choices of land use. The every world of buildings, artifacts, and domesticated landscape is a design world, one shaped by human (Van Der Ryn and Cowan, 1996).

Some environmental problems have arisen from design problems. Design can have a crucial impact upon the environment in many different ways. This is because every design decision is an environmental decision. Design is a consequence of how things are made, and the world has been shaped by the designers. The present forms of everything in the world have been

derived from design. It is clear that design has been previously used only to meet human needs. Unfortunately, in many past situations environmental effects were ignored during the design stage. Design has not been taught in the context of its ecological impact. Many practices in the design field have been done with unsustainable design principles. The environmental problems have boosted the sustainable explorations necessary for protecting ecological system in order to address and find solutions to the problems. Scientists, planners and designers have questioned the effectiveness of design and have suggested incentives as alternatives. At the end of 20th century, the power of design for to solve the problem and the potential of design for sustainability have been noticed; an integration that goes from ecological processes and functions to design has started. Design and its potential have been regarded a creative problem solving activity. While ecological sciences provide the knowledge and guidance, design provides creative solutions for the environmental problems.

In a world facing a future characterized both by expanding metropolitan regions and by ecological crisis, it is imperative that we re-think the relationship of urban dwellers to the natural environment. The 21st century is expected to be the first in history in which a majority of humanity lives in cities, and if present trends continue, it may also be the one in which those urban populations inflict irreversible damage on the earth's living systems (Eisenstein, 2001).

Designers and design critics are increasingly emphasizing the actual or, potentially, radical nature of an ecological approach to design which implies a new critique—a recognition of the fact that to adopt an ecological approach to design is, by definition, to question and oppose the status quo (Madge, 1997). In this context design has a crucial role to play in achieving sustainability and to provide solutions for environmental problems. In parts of the world dominated by humans, landscape design can have significant and positive environmental effects (Helfand et al., 2006).

Ecological design explicitly addresses the design dimension of the environmental crisis. It is not a style. It is a form of engagement and partnership with nature that is not bound to a particular design profession (Van Der Ryn and Cowan, 1996).

In recent years ecological design has been applied to an increasingly diverse range of technologies and innovative solutions for the management of resources. Ecological technologies have been created for the food sector, waste conversion industries, architecture and landscape design, and to the field of environmental protection and restoration (Todd et al., 2003).

As environmental problems escalate, ecological design in landscape architecture has increasing in academia and practice. Ecological design is an integrative ecologically responsible design discipline. Ecological design has been emerged as a means to model ecological processes and functions, and therefore as a model for sustainability. Today's ecological landscape design movement tends to address design problems.

2. The relationship between ecology, sustainability and design

Ecology, sustainability and design are different fields, but they have been merged together in recent years. This is because human lifestyle is having an increasingly negative impact on the surrounding environments.

Ecology, in the 100 years since its inception, has increasingly provided the scientific foundation for understanding natural processes, managing environmental resources and achieving sustainable development. By the 1960s, ecology's association with the environmental movement popularized the science and introduced it to the design professions (e.g. landscape architecture, urban design and architecture) (Makhzoumi, 2000).

“Ecology” in the profession of landscape architecture and planning can’t be understood solely as meaning the relationship between nonhuman life forms and their environment. The term ecology is traditionally used as shorthand for the sum of the biophysical forces that have shaped and continue to shape the physical world. Thus there are other dimensions to be recognized if we are to understand the key nature of ecology: that of process, integration, and humanity (Ahern et al., 2001).

The relationship between design and ecology is a very close one, and makes for some unexpected complexities (Papanek, 1995). Ecology explains how the natural world is and how it behaves, and design is also the key intervention point for making sustainability in ecology (Figure 1.). The knowledge gained from ecology can influence landscape design.

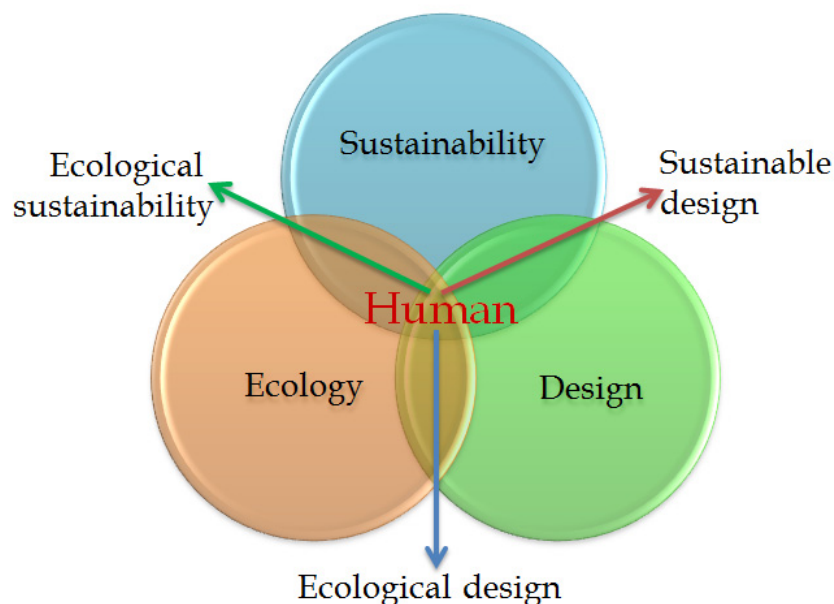


Figure 1. The relationship between ecology, sustainability and design

In landscape architecture ecology’s emphasis on natural processes and the interrelatedness of landscape components influenced outlook and method and prompted an ecological approach to design (Makhzoumi and Pungetti, 1999). The ecological component is crucial in landscape design according to the principles of sustainability.

The typical relationship of designer and scientist presumes that most of what can be known is known. The designer is the creative partner; the scientist is an interactive book. Since the scientific base for ecological design is nascent, the nature of this relationship is flawed.

Science and design are complementary ways to generate knowledge (and therefore both are creative endeavors). Scientists solve problems inductively, forming generalized principles from specific observations (Figure 2.). Designers use general principles to solve specific problems deductively. The knowledge available for ecological design would greatly increase if designed landscapes were used as ecological research sites. Designed landscapes that are typical of the surrounding region, with one to a few clear themes and repeated patterns (replication), are potential ecological research sites (Galatowitsch, 1998).

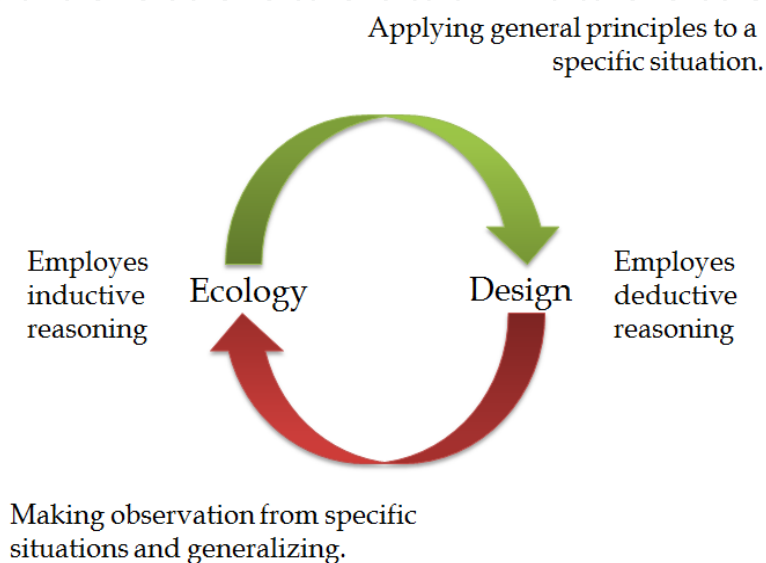


Figure 2. Design and ecology are complementary problem-solving techniques (Galatowitsch, 1998)

3. Ecological sustainability

Sustainability is not a single movement or approach. It is varied as the communities and interests currently grappling with the issues it raises. On the one hand, sustainability is the province of global policy makers and environmental experts. On the other hand, sustainability is also the domain of grassroots environmental and social groups, indigenous peoples preserving traditional practices, and people committed to changing their own communities. The environmental educator David W. Orr calls these two approaches *technological sustainability* and *ecological sustainability*. While both are coherent responses to the environmental crisis, they are far apart in their specifics. Technological sustainability, which seems to get most of the airtime, may be characterized this way: “every problem has either a technological answer or a market solution. There are no dilemmas to be avoided, no domains where angels fear to tread.” Ecological sustainability is the task of finding alternatives to the practices that got us into trouble in the first place; it is necessary to rethink agriculture, shelter, energy use, urban design, transportation, economics, community pattern, resource use, forestry, the importance of wilderness, and our central values. While the two approaches have important points of contact, including a shared awareness of the extent of the global environmental crisis, they embody two very different visions of a sustainable society (Van Der Ryn and Cowan, 1996).

A goal of ecological design is to help meet this vision of ecological sustainability, by finding ways of manufacturing goods, constructing buildings, and planning more complex enterprises, such as business and industrial parks, while reducing resource consumption and avoiding ecological damage to the degree possible (Shu-Yang et al., 2004).

Ecological design strives to achieve an increasing reliance on renewable sources of energy and materials, while maintaining standards of quality of goods and services and reducing overall resource consumption, waste generation, and ecological damage through efficiencies of use, re-use, and recycling.

Ecological design provides a framework for uniting conventional perspectives on design and management with environmental ones, by incorporating the consideration of ecological concerns at relevant spatial and temporal scales. If the principles of ecological design are rigorously applied, important progress will be made towards ecological sustainability (Shu-Yang et al., 2004).

Landscape design mostly depends on natural resources, so ecological sustainability is very important. Landscape design contributes to the ecological sustainability.

4. Sustainable design

There is no verifiable starting point for the current sustainable design movement. It seems to have converged from several different broad ideas concerning our relationship with the natural world. Some of the key figures who have contributed to the discussion include Frederick Law Olmsted and Calvert Vaux, John Muir, Theodore Roosevelt and Gifford Pinchot, Aldo Leopold, Rachel Carson, and Ian McHarg (Cook and VanDerZanden, 2011).

Sustainability is an ecological term that has been used since the early 1970s to mean: "the capacity of a system to maintain a continuous flow of whatever each part of that system needs for a healthy existence," and when applied to ecosystems containing human beings refers to the limitations imposed by the ability of the biosphere to absorb the effects of human activities. The term sustainable development was first used in the early '80s, but was popularized by the Brundtland Report of 1987. "Sustainable" has become the buzzword of the '90s in the same way "green" was in the '80s, and is equally open to different interpretations and misuse. The Brundtland Report adopted a global perspective on the consumption of energy and resources, and emphasized the imbalance between rich and poor parts of the world, arguing that: "Sustainable development requires that those who are more affluent adopt lifestyles within the planet's ecological means." However, because the report also argued that economic growth or development is still possible as long as it is green growth, this has been interpreted by many to endorse a "business as usual" approach, with just a nod in the direction of environmental protection. This ignores the real meaning of sustainable development, which is enshrined in the widely quoted concept of "futuraity": "...meeting the needs of the present without compromising the ability of future generations to meet their own needs."

When applied to design, this not only introduces or reintroduces the ideas of ethical and social responsibility, but also the notion of time and timescale. Thinking about the life cycle of products through time, and considerations about design for recycling, have led to the concept of DfD (Design for Disassembly) followed by the idea of going Beyond recycling towards the design of long-life, durable products. These two concepts are not as contradictory as they sound, as Victor Papanek has recently remarked: "To design durable goods for eventual disassembly may sound like an oxymoron, yet it is profoundly important in a sustainable world. The term "sustainable design" has begun to be used in the last 15 years or so to refer to a broader, longer-term vision of ecological design. At the Centre for Sustainable Design, established at the Surrey Institute of Art and Design in July 1995, sustainable design means "analyzing and changing the 'systems' in which we make, use, and dispose of products," as opposed to more limited, short-term DFE. The ECO2 group makes a similar distinction between "green design, project-based, single issue and relatively short-term; and sustainable' design, which is system-based, long-term" ethical design. Emma Dewberry and Phillip Goggin have also explored the distinctions between ecological design and sustainable design; arguing that, whereas ecological design can be applied to all products and used as a suitable guide for designing at product level: "The concept of sustainable design, however, is much more complex and moves the interface of design outwards toward societal conditions, development, and ethics.... This suggests changes in design and the role of design, including an inevitable move from a product to a systems-based approach, from hardware to software, from ownership to service, and will involve concepts such as dematerialization and "a general shift from physiological to psychological needs." Finally, they emphasize the extent to which consumption patterns must change, and refer to the inequality between developed and developing nations, the fact that 20 percent of the world's population consumes %80 of the world's resources and conclude that ecological design does fit into a global move toward sustainability, but has many limitations in this context. This is the point made by Gui Bonsiepe, who has expressed the fear that ecological design will remain the luxury of the affluent countries while "the cost of environmental standards would be shifted onto the shoulders of the Third World." (Madge, 1997).

Sustainability can be viewed as the long-term outcome of maintaining landscape integrity. Designing for sustainable landscapes necessitates a holistic and integrative outlook that is based on ecological understanding and awareness of the potentialities and limitations of a given landscape. Such understanding ensures that in accommodating future uses their impact on existing ecosystems and essential ecological processes and biological and landscape diversity is anticipated. This will allow for healthy ecosystems and long-term ecological stability (Makhzuomi and Pungetti, 1999).

Designs that promote sustainable landscapes should be simultaneously aware of local values and resources as well as regional and national ones, as sustainability is the domain of both. Further, achieving landscape sustainability requires patience, humility and a design approach that attends to scale, community, self-reliance, traditional knowledge and the wisdom of nature's own (Van der Ryn and Cowan, 1996).

Whereas maintaining landscape integrity and designing for sustainability can be seen as the practical objectives of ecological landscape design, the design of creative and meaningful places addresses aesthetic concerns.

The following is a palette of terms that in some way define or refer to sustainable design:

- Design for environment,
- Ecological design (ecodesign/eco-design),
- Environmental design,
- Environmentally oriented design,
- Ecologically oriented design,
- Environmentally responsible design,
- Socially responsible design,
- Environmentally sensitive product design,
- Sustainable product development,
- Green design,
- Life-cycle design,
- Dematerialization,
- Eco-efficiency design,
- Energy efficient design, and
- Biodesign (Deniz, 2002).

5. The role of technology in ecological design

Environmental problems become an increasingly important aspect of the designer's work to minimize the risks and to solve the problems. Because of the rapid technological development, environmental problems increase day by day. On the other hand, new technologies often tend to be less dangerous than what they replace, and hence designers may find themselves in the forefront of identifying problems which must be addressed by technology. Sometimes, existing technologies may not be able to provide the solution, and the designer may have to influence the development of a new technological approach. Designers must also follow technological developments in order to be sure of incorporating the most environmentally advanced technologies (Deniz, 2002).

Technology has been the principal method by which we intervene on the land and modify the ecosystems to ensure our existence, yet its various manifestations are most often ignored in discussions of the designed landscape. In fact, much of the rationale for this exhibit might be based upon the obfuscation of ecological clarity by technology and the subsequent employment of more benign and expressive techniques for bringing back such clarity. In the ordinary landscape, the instances in which intentional land design aims at a higher, symbolic meaning in some decipherable form are few when compared with the countless millions of ordinary landscape structured by the dominant, operative, contemporary technological paradigms. In one sense, we have covered up our ecosystems with our technologies; we have obscured a degree of innate clarity of the former with the vast

complexities of the latter. While science and technology have made it possible to comprehend deeper levels of ecosystem knowledge, they have also enabled the physical cover-up and subsequent concealment of dimensions of the landscape once readily accessible to more primal peoples. With technological hegemony, our ecosystems have gained little and lost a lot (Thayer Jr., 1998).

This raises the whole issue of the relationship between design and the “Appropriate Technology” (AT) movement in the last twenty to thirty years. Schumacher (1973) coined the term “intermediate technology” to signify “technology of production by the masses, making use of the best of modern knowledge and experience, conducive to decentralization, compatible with the laws of ecology, gentle in its use of scarce resources, and designed to serve the human person instead of making him the servant of machines”. The central tenet of appropriate technology is that a technology should be designed to be compatible with its local setting. Examples of current projects that are generally classified as appropriate technology include passive solar design, active solar collectors for heating and cooling, small windmills to provide electricity, roof-top gardens and hydroponic greenhouses, permaculture, and worker-managed craft industries. There is general agreement, however, that the main goal of the appropriate technology movement is to enhance the self reliance of people on local level. Characteristics of self reliant communities that appropriate technology can help facilitate include: low resource usage coupled with the extensive recycling; preference for renewable over nonrenewable resources; emphasis on environmental harmony; emphasis on small-scale industries; and a high degree of social cohesion and sense of community (Roseland, 1997).

6. Emerge of ecological landscape design

Landscape architecture is a multi-disciplinary field, incorporating aspects of; botany, horticulture, the fine arts, architecture, industrial design, geology and the earth sciences, environmental psychology, geography, and ecology.

Landscape architecture has ecological thinking at the core of its legacy (Mozingo, 1997). As a result of a trend favoring ecological perspectives in design, significant changes have occurred in the landscape architecture profession in recent decades through the move to integrate ecological perspectives (Hooper et al., 2008).

Thinking ecologically about design is certainly not a “new” idea. Since ancient times “designers” looked to nature for “solutions” to their common problems; they saw nature as the perfect model to follow. Even though, in recent times, an increase in ecological education and environmental awareness is apparent among design professionals, there is still the need to better understand the expression of ecology through design (Lomba-Ortiz, 2003). In the face of the environmental problems new approaches to reconciling the divide between ecology and design have been explored in landscape architecture.

Since the 1960s, ecology has increasingly influenced the design professions, providing for a holistic and dynamic outlook on nature, environment and landscape. The different

dimensions of ecology have come to imply the ability to think broadly, to search for patterns that connect and to observe nature with insight. Alternatively, ecological knowledge allows a comprehensive understanding of landscape as the outcome of interacting natural and cultural evolutionary processes which account for pattern, diversity, sustainability and stability (Makhzuomi and Pungetti, 1999).

To date, however, ecological design has been principally concerned with the realistic emulation of ecological form, function, and, where possible, process. As an outgrowth of, and to some degree, a fusion between landscape architecture, ecology, environmental planning, and the building science aspects of architecture, there is a distinctive functional emphasis in the discipline. Ironically, artistic elements and visual aesthetics have not been a priority in a discipline that bears the label of "design." I would attribute this principally to the dominance of landscape architecture in influencing ecological design, itself (until recently) a discipline characterized by a schism between garden design and horticulture in one domain, and technical ecologists concerned with ecological restoration and reconstruction in the other. This remediative, reactive "applied ecology" practice of landscape architecture along with related environmental professions have understandably been the progenitors of the new discipline of ecological design, largely (and understandably) as a response to global environmental crises (Lister, 2005).

Motivated by environmental values, landscape architects became increasingly knowledgeable about ecological principles and systems (Meyer, 2000). Ecology, the study of interactions between organisms and their environments, has long been a compelling theme for faculty, practitioners, and students of landscape design and planning. Frederick Law Olmsted's visionary public designs, Jens Jensen's native plantings, May Watt's observations of vernacular landscapes, and Ian McHarg's book, *Design with Nature*, are all milestones of ecological thinking in landscape design and planning (Johnson and Hill, 2001). McHarg (1969), Spirn (1984) and Hough (1995) played seminal roles in applying theories and principles of ecological landscape design to urban areas (Özgüner et al., 2007). Ian McHarg who, perhaps more than any other, popularized ecology in landscape architecture. Patrick Geddes is the initiator of an ecological approach in design and planning and because he offered an integrative view of the environment that embraced urban design, landscape design and planning. John Tillman Lyle offers a comprehensive approach embracing theory, practice and method (Makhzuomi and Pungetti, 1999).

In the late 1860's Frederick Law Olmsted supported the idea that landscape architects were stewards of the land. Olmsted's designed landscapes borrowed aesthetically from the picturesque but he was overtly conscious of ecological processes playing a critical role in the function and design of landscape spaces (Ware, 2004).

The early influence of ecology can be traced to the work of late nineteenth century visionary biologist Patrick Geddes, the conceptual initiator of an ecological approach to urban and landscape design and landscape planning. Patrick Geddes had a clear, overall conceptual strategy for improving the manmade environment and for advocating a sympathetic coexistence with the natural environment. In his 'biological principles of economics' he came closest to the present day concept of sustainability (Makhzuomi and Pungetti, 1999).

Ecological thinking was only resumed with the publication of Ian McHarg's (1969) 'Design with Nature'. The significance of McHarg's work, however, lies elsewhere, namely in introducing ecological understanding to the profession. McHarg believed that ecology had the potential to emancipate landscape architects from the static scenic images of ornamental horticulture by steering them away from arbitrary and capricious designs (Makhzuomi and Pungetti, 1999). Ian McHarg's work fore grounded much of the early sustainable design discussions of the 1970's and into the 1980's. Carl Steinz's, Fred Steiner's, and Rob Thayer's earliest work was a critique of McHarg's methods (Ware, 2004).

John Tillman Lyle's (1985) 'Design for Human Ecosystems' is a comprehensive integration of ecological concepts and landscape design. The term human ecosystems is proposed by Lyle to signify the totality of the landscape at hand as a warning against a strongly visual notion of landscape assessment and as a reminder that the landscape needs to be evaluated as the outcome of natural and cultural processes. Lyle argues the necessity of making full use of ecological understanding in the process of designing ecosystems; only then can "we shape ecosystems that manage to fulfill all their inherent potentials for contributing to human purposes, that are sustainable, and that support nonhuman communities as well".

Three aspects of Lyle's (1985) work are of direct relevance in establishing the conceptual foundation for ecological design. The first is that he attempts to tackle the complexity of design method and offers a critical investigation of the design process in the context of ecosystem, its function, structure and ecological (rather than economic) rationality. The second is that he includes 'management' as an integral part of ecosystem design, arguing that ecosystems like any organic entity have a variable future and as such, their design should be probabilistic; it is difficult to predict the changes that will take place. The implication here is that design is an ongoing process and that the final product of design is only one stage in this process; it should not be the objective. It also implies that design is interactive because it takes into account future change resulting from the designed system's interaction with its environment. A third aspect of Lyle's work is that he breaches the professional categorization of landscape architecture and landscape planning. The terms 'landscape design' and 'landscape planning' are often used interchangeably, however, uses 'design' as giving form to physical phenomena 'to represent such activity at every scale'. In this he follows others (Steinitz, 1979 and McHarg, 1969) who refer to the regional planning scale while using 'design'. Lyle viewed landscape planning's focus on the rational as inevitably excluding the intuitive (Makhzuomi and Pungetti, 1999).

More recently, designers such as Le Corbusier and Frank Lloyd Wright, among many others, have attempted, with some degree of success, to address ecological issues through their designs. "Green Architecture," "Alternative Architecture," "Sustainable Design," and "Ecological Design," are some of the terms commonly used today to describe a special expression of design that takes as its primary driving force nature's processes. Van Der Ryn and Cowan (Ecological Design, 1996) defined this form of expression as "any form of design that minimizes environmentally destructive impacts by integrating itself with living processes." A "new" movement among design professionals has been developing for some

time now with many of its principles synthesized by the current "green" movement in design (Lomba-Ortiz, 2003).

Ecological design is an emerging interdisciplinary field of study and practice. In fact, many would argue that it is a transdisciplinary field, concerned with the creation of entirely new applications that may emerge from its progenitor disciplines or arise from a synthesis of several. Influenced principally by ecology, the environmental sciences, environmental planning, architecture, and landscape studies, ecological design is one of several rapidly evolving (theoretical and practical) approaches to more sustainable, humane, and environmentally responsible development. As such, it may also be considered a critical approach to navigating the interface between culture and nature. In the broadest sense, ecological design emerges from the interdependent and dynamic relationship between ecology and decision making.

Van Der Ryn and Cowan (1996) described ecological design as a hinge that connects culture and nature, allowing humans to adapt and integrate nature's processes with human creations. In modern industrialized societies, human culture and nature are perceived and treated as separate realms, yet their interface offers fertile ground for the creation of new, hybridized natural/cultural ecologies and the rehabilitation and re(dis)covery of others. Ecological design is inspired by the nexus of these worlds and the urgent need to blur the boundary between them; it seizes on the creative tensions between them and, as such, may offer opportunities for and insights to a re(dis)covered place of "living lightly" with the land (Lister, 2007).

By the beginning of the 21st century, ecological design had emerged as an expression of a sustainability world-view, which seeks to integrate the human enterprise with a sustainable harvest of resources, while ensuring that stresses caused to natural ecosystems are within the bounds of viability. If this can be achieved, the integrity of both the human economy and of natural ecosystems can be maintained. As such, ecological design is an all-encompassing concept, as it deals with the sustainability of:

- The enterprises of families, neighborhoods, and cities;
- The construction of buildings in a manner that decreases resource use and environmental damage to the degree possible;
- The manufacturing of certifiably green products;
- The organic production of foods and other renewable resources;
- The integration of these various activities within ecologically planned mutualisms, such as industrial and business parks, which are designed to maintain high production while reducing the use of resources and minimizing waste; and
- The maintenance of indigenous biodiversity (Shu-Yang et al., 2004).

Landscape architects continue to speculate how we can design with the materials of nature and not have the result be confused for nature itself (Ware, 2004). Beth Meyer asserts, 'to some it might seem odd that landscape architects looked toward art and design theory and practice when seeking direction about folding ecological principles and environmental values into their creative processes. But this simultaneous look to art as well as science and

to theories of site specificity and phenomenology as well as ecology was critical to the successful integration of environmentalism into landscape architectural design.' (Meyer, 2002).

7. Ecological landscape design

Ecological landscape design is based on an ecological understanding of landscape which ensures a holistic, dynamic, responsive and intuitive approach (Figure 3.). It is holistic because it simultaneously considers past and present as well as local and regional landscape patterns and processes. It is responsive because it develops from a realization of the constraints and opportunities of context whether natural, cultural or a combination of both. Ecological landscape design is guided by three fundamental, mutually inclusive objectives: the maintenance of landscape integrity; promoting landscape sustainability; and reinforcing the natural and cultural spirit of place. Ecological landscape design engages the designer's rational, intellectual, emotional and creative capabilities (Makhzoumi and Pungetti, 1999).

Ecological design develops out of two areas of inquiry. On the one hand, it is the outcome of ecology's interface with the environmental design professions. Despite the differing perspectives and focus of interest, a number of common concepts have been outlined. On the other hand, ecological landscape design also utilizes fundamental ecological. Input from these two areas of inquiry forms the foundation for ecological landscape design which is here seen as integrating four overlapping attributes (Figure 3.).

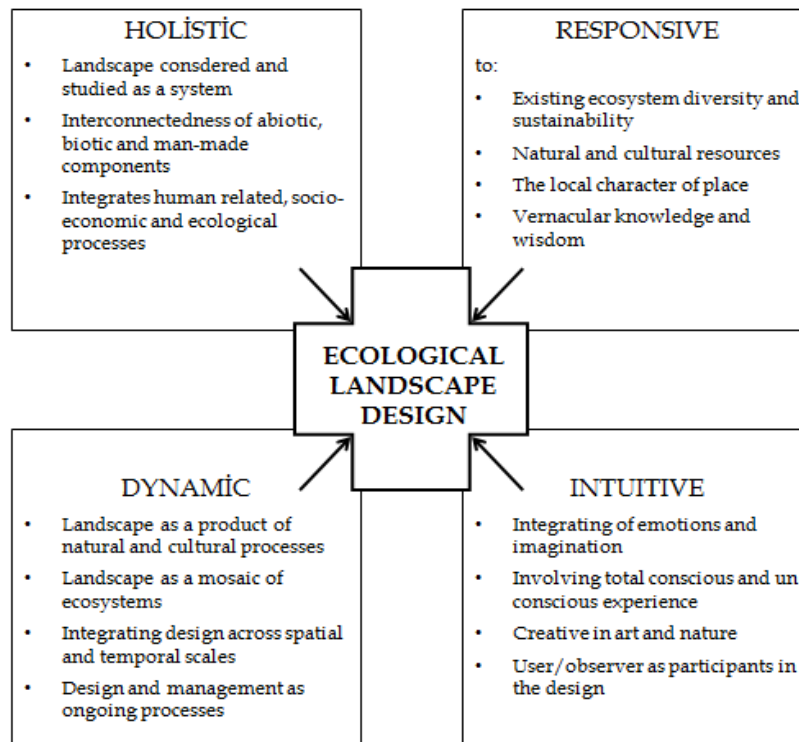


Figure 3. Framework for ecological landscape design, drawing on concepts from ecology (left) and ecological design (right)

The first is a holistic approach to landscape understanding, integrating abiotic, biotic and cultural landscape components. The second is a dynamic approach in which landscape is investigated along two continuums: a spatial one, i.e. movement between a larger scale and a local one; and a temporal one representing the evolutionary historical development of the landscape. The third is ecological landscape design's responsiveness to the constraints and opportunities of context whether natural, cultural or a combination of both. Responsiveness also dictates an anticipatory approach that considers the impact of the design on existing ecosystems and resources. Finally, ecological landscape design is intuitive, encompassing not only the rationality of the outer world but also the neglected 'intangible relationships' of the inner world. This intuitive approach embraces a new definition of creativity that departs from the formal, i.e. object-centered, appearance-oriented aesthetics to a phenomenological participatory aesthetics where the emphasis is on the totality of human experience of the object (Makhzuomi and Pungetti, 1999).

Reviewing ecology's interaction with the environmental design professions reveals a wide range of concepts, solutions and approaches (Figure 4.). The contributions in architecture and the urban landscape design include practical strategies (e.g. energy conservation, ecological networks) and design solutions to specific problems (e.g. earth-sheltered architecture and bioclimatic design). The interaction of ecology and landscape architecture has been more extensive, leading to a holistic approach to landscape design. All the contributions, however, find inspiration in nature and aim to shape man's environment sustainably and 'beautifully'.

Ecological landscape design integrates input from landscape ecology and design, both of which are seen as providing parallel and complementary, albeit different methodological approaches. The analytic and descriptive nature of landscape ecology, the science, provides for a holistic understanding of existing landscapes, while the intuitive and creative problem-solving capabilities of design prescribe alternative courses for future landscape development (Makhzoumi, 2000).

In the different steps of the design process a lot of information has been needed to analyze and evaluate ecological processes and functions. Thus ecological design has been interdisciplinary field of study and practice.

Over the past 20 years landscape architecture has re-invested in ecologically driven design. Ware (2004) investigates the following typologies:

- Interpretation and Environmental Education
- Environmental Remediation/Re-vegetation
- Re-Use/Re-programming
- Eco-Revelatory Design
- The Art of Landscape Function
- Intertwining Ecologies
- Constructed Ecologies
- Simulated 'natural' Attractions

The typological framework aims to illustrate and differentiate current methods of approaching ecological design in landscape architecture. The eight categories include a critical reflection as to how the work itself may not be addressing much of the dynamic, ecological processes that the projects are predicated upon (Ware, 2004).

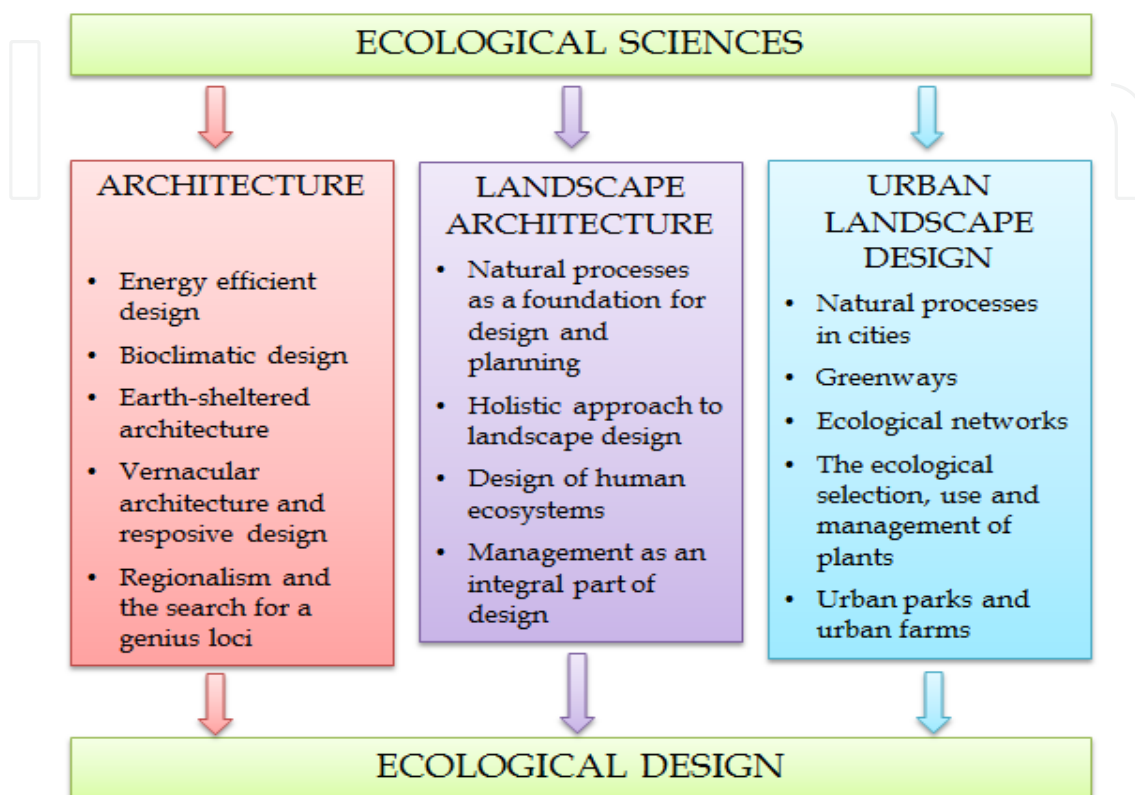


Figure 4. The interface of ecology with architecture, landscape architecture and urban landscape design (Makhzuomi and Pungetti, 1999)

7.1. Principles of ecological landscape design

The main ecological principles concerning cities are that:

- Cities are ecosystems;
- Cities are spatially heterogeneous;
- Cities are dynamic;
- Human and natural processes interact in cities; and
- Ecological processes are still at work and are important in cities.

The first three principles address the structure of cities and the change in structure through time. The remaining two principles focus on ecological processes in cities (Table 1.).

The first principle suggests that landscape design theory and management practice must address all the components of such systems. Urban ecosystems include four broad kinds of components (organisms, a physical setting and conditions, social structures, and the built environment) all interacting with one another. Landscape designs and management

strategies that are aimed at one or two of these components or interactions, in reality have the potential to affect them all. Landscape designs that acknowledge and work with the connections between the social, biological, physical, and built components of the system are much less likely to produce unintended negative consequences, and are more likely to contribute to ecological sustainability. Furthermore, enhanced quality of urban life depends on all components of the urban ecosystem, not just some of them (Cadenasso and Pickett, 2008)

Principles	Summary of Implication for Landscape Design
Cities are ecosystems	Design affects all four components of human ecosystems.
Cities are heterogeneous	Design should enhance heterogeneity, and its ecological functions.
Cities are dynamic	Design must accommodate internal and external changes projects can experience.
Human and natural processes interact in cities	Design should recognize and plan for feedbacks between social and natural processes.
Ecological processes remain important in cities	Remnant ecological processes yielding ecological services should be maintained or restored.

Table 1. A brief summary of the general implications of each of the five principles of urban ecology for ecologically motivated landscape design and management

The second principle suggests that interactions and transfers among patches within the urban matrix are affected by landscape design and management. Urban landscape design should carefully consider the heterogeneity and its role in maintaining desirable functions such as biodiversity, storm water retention, microclimate mitigation, and carbon sequestration. The interaction between a particular landscape project and adjacent patches of similar or contrasting landscape structure can enhance the function and value of individual projects. This may mean paying particular attention to the boundaries between contrasts within or between projects to enhance or protect from exchanges.

The third principle means that landscape designs should accommodate change. Natural disturbances, extreme climate events, shifting economic investment or disinvestment, the maturation of households, and the aging of or renovation of infrastructure are but some of the examples of the kinds of dynamism that landscape designs and management will have to respond to. Persistent equilibrium in cities is unlikely. Designs that plan for successional changes in vegetation have redundancies in the face of disturbance, or that encourage use by different age groups may be more resilient in changing cities.

The fourth principle suggests that both of these major categories must be addressed as landscape design goals. A design that satisfies only obvious social criteria, such as recreation or efficiency of commerce, misses an opportunity to contribute to ecosystem services that

may ultimately have great social value. All landscape designs and management schemes should be judged for their ability to contribute to both social and ecological goods and services, and to reduce both social and ecological risks and vulnerabilities.

The fifth principle means that landscape designs and management practices have the opportunity to preserve and promote those basic biological processes upon which human health and well-being depend. It will be important to provide for these functions even in areas beyond the large green parcels usually targeted for this kind of benefit. The control of water flow and infiltration, the retention of limiting and hence potentially polluting nutrients, the sequestration of carbon dioxide, the neutralization of toxics, the maintenance of soil respiration, the production of biomass, the amelioration of climate extremes, the mitigation of natural disturbance, and the preservation of biodiversity, are but some of the processes that can exist in various places in designed systems. Landscape designs and management protocols can be purposefully planned so as to maintain, or in some cases restore, as many of these kinds of natural processes as possible throughout the urban matrix. As such, landscape design and management can provide creative new ways to insinuate ecological processes in cities (Cadenasso and Pickett, 2008).

Ecologically designed urban landscapes are ones that can use both ecological processes and human values as form-giving elements. In addition to their many environmental benefits, these landscapes -which include systems such as energy efficient buildings, storm water infiltration, sewage treatment wetlands, and urban forests- can also contribute to local cultures of sustainability that, like all cultures, both shape and are shaped by the built and designed environment. If they are to do so, however, their designers must think clearly about the experience of the users of the urban landscape, and particularly about the meanings and lessons that they derive from their surroundings. The ways that people learn from and respond to the urban environment are critical to the prospects for sustainability, if for no other reason than that for most of us, it is the landscape of the city that helps to shape our view of nature and our relation to it (Eisenstein, 2001).

Ecological landscape designs fall into four categories:

1. Preservation of existing, functioning ecological systems;
2. Enhancement or re-establishment of degraded ecological systems;
3. Intensification of ecological processes to mitigate potential or existing ecological degradation; and
4. Environmental interventions which reduce nonrenewable resource consumption (Mozingo, 1997).

Van Der Ryn and Cowan (1996) have pointed out principles of ecological design Table 2.. The first principle grounds the design in the details of place. In the words of Wendell Berry, we need to ask, "What is here? What will nature permit us to do here? What will nature help us to do here?" The second principle provides criteria for evaluating the ecological impacts of a given design. The third principle suggests that these impacts can be minimized by working in partnership with nature. The fourth principle implies that ecological design is

the work not just of experts, but of entire communities. The fifth principle tells us that effective design transforms awareness by providing ongoing possibilities for learning and participation. Taken together, these five principles help us to think about the integration of ecology and design.

Principles	Summary of Implication for Landscape Design
Solutions grow from place	Ecological design grows from an intimate, detailed knowledge of the place and its nuances.
Make nature visible	Make sure natural cycles and processes are visible to bring the designed environment back to life.
Design with nature	Nature's living processes offer opportunities to design using natural cycles, natural waste, and regeneration as part of the total design.
Ecological accounting informs design	By tracing the environmental impacts of a design, we can discover the more ecologically sound options.
Everyone is a designer	Listen to every voice in the design process.

Table 2. Principles of ecological design

7.2. Examples of ecological landscape design

7.2.1. *The West Davis Pond*

The West Davis Pond in Davis, California, is exemplary of the new landscape space of ecological design. The subdivision of a single family and low-rise apartment neighborhood required capacity improvement of an existing storm-water-treatment settling pond. This prosaic infrastructure requirement innovatively integrates a constructed habitat for numerous over-wintering migratory birds and resident wildlife whose wetland habitats have largely been destroyed in the Central Valley.

The pond had pre-existing development on three sides: an arterial roadway edged by backyard fences, a long edge of directly adjacent backyard fences, and warehouse commercial uses. On the fourth side, the project developers and their team of engineers, environmental scientists, and landscape architects conceived of the pond as integral to the open space of the new development. In lieu of a more typical suburban park, between the housing and the pond, a bike path, part of a famous city-wide system, incorporates two pond overlooks and a constructed arroyo channel as a children's play area. Between the manicured, exotic landscape of the housing and the habitat planting of the pond, transitional "native planting" envelopes the bike path, overlooks, and play area (Figure 5.). Most of the species are not native to this part of California, and many are unhealthy or dying.

As one of the first storm-water-treatment wildlife ponds in the Central Valley, and one of the first wetland restoration projects within an urban context, the project is laudable in ways-it is based on sound ecological science, it achieves its clearly stated ecological goals, it

is innovative, and it manifests strong community support. The project was done with conscience, care, and the considerable risk that precedents always entail (Mozingo, 1997).



Bike path



Birding walks



How it looked in 2007



How it looked in 2010



Early fall at the pond

Figure 5. The West Davis Pond (Anonymous, 2012)

The West Davis Pond is a new kind of ecologically integrated project, with measurable ecological benefits that we want to increasingly infiltrate into the landscape. The Pond is an enhanced wetland wildlife habitat, while its primary purpose is to retain storm water runoff and help prevent flooding. In the dry months, water is provided by a supplementary well.

The Pond is enclosed by a security fence and is designated a "Wildlife Preserve" and "Sensitive Habitat Area" by the City of Davis. Native trees and shrubs grow on the slopes around the Pond and provide habitat for a diversity of wildlife (Anonymous, 2012).

7.2.2. The Glenn W. Daniel King Estate Park

The Glenn W. Daniel King Estate Park encompasses eighty acres of a north-south ridge overlooking the East Bay Hills and an expansive panorama of the San Francisco Bay. The park is the largest open space and only urban wild land west of Interstate 580, the city's social and physical divide. The Glenn W. Daniel King Estate Park is not blueprint for a park constructed as a single project. Rather, it is a guide for a sustained effort to bring to fruition a park that is ecologically healthy and well integrated into the social life of its community (Figure 6.). The park lies within a home owning, middle-class, primarily African American neighborhood considerably integrated with European American, Latino and Asian American residents (Mozingo et al., 1998).

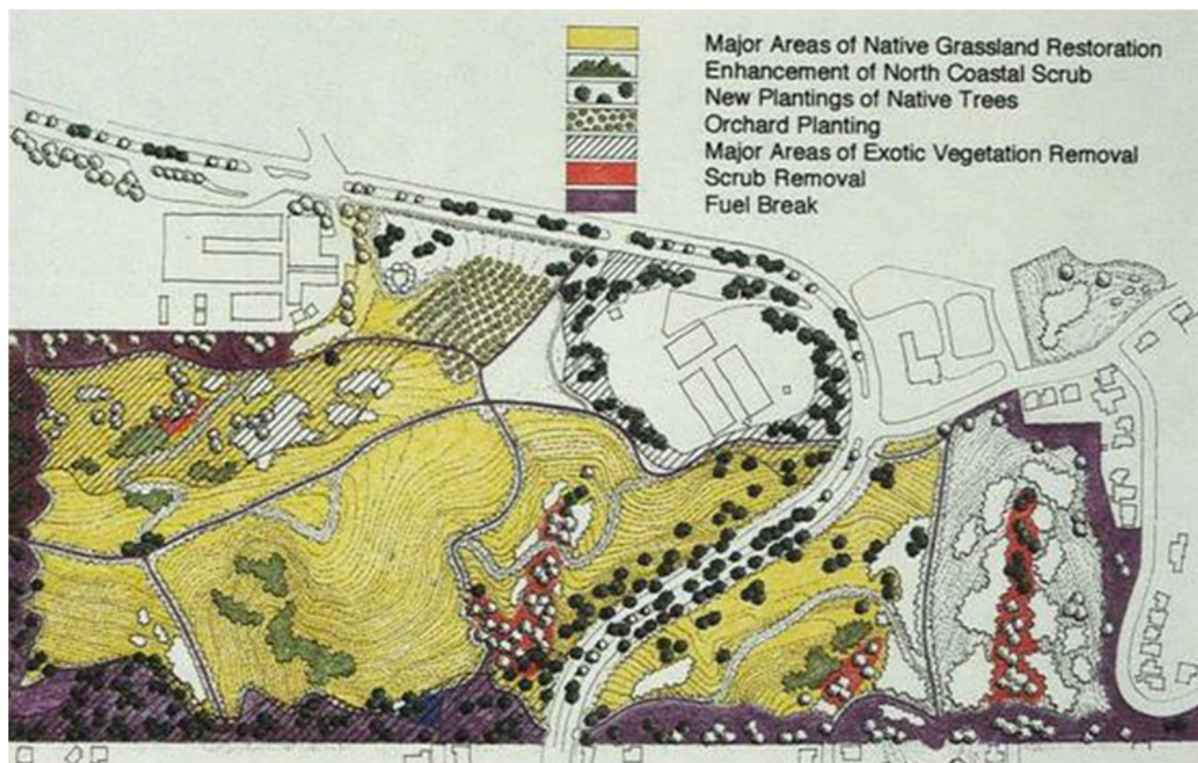


Figure 6. The Glenn W. Daniel King Estate Park Master plan (Mozingo et al., 1998)

A partnership ethic respects both cultural diversity and biodiversity. In the hills above Oakland, California, a culturally diverse middle-class neighborhood consisting of a majority of African Americans along with many European, Asian, and Latin Americans worked in partnership with each other and with landscape architect Louise Mozingo of the University of California, Berkeley. The goal was to restore biodiversity to the oak groves from which the city derived its name and ecological heritage. Together they devised a plan to develop the neighborhood's The Glenn W. Daniel King Estate Park to benefit from the

diversity of perennials grasses, oak savannahs, and brushy chaparral indigenous to the area. At the same time, they revamped hiking trails, added a recreation center, and increased security. The resulting master plan provided “a template for how communities can become active partners in the fulfillment of their own environmental visions” (Merchant, 2004).

7.2.3. Village of Yorkville Park

The idea of this urban park dates back to the late 1950s when a block of Victorian-era row houses was demolished along Cumberland Street to allow for the construction of the Bloor Danforth subway line. The park sits at the cusp of two neighborhoods: the small-scale old Yorkville neighborhood with its late 19th and early 20th century row houses, and the high-rise commercial core that has built up along the Bloor Street corridor since the subway opened. For years, this highly visible site remained a parking lot. Activist neighbors fought to build a public place to bring the neighborhood together rather than to divide it. Finally, in 1991, the City of Toronto Department of Parks, Forestry and Recreation announced an international design competition (Figure 7.).

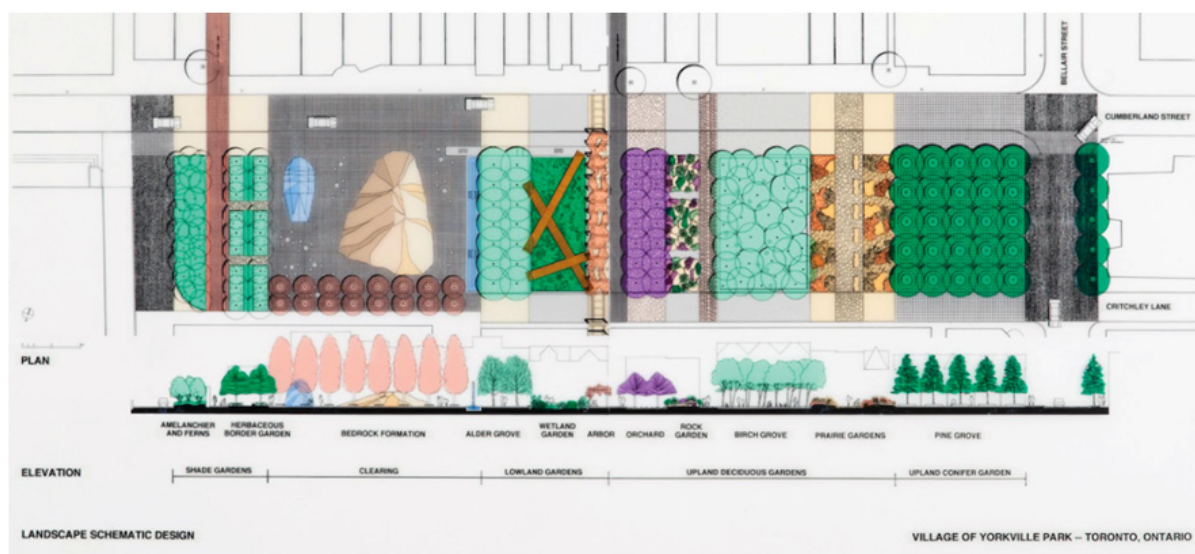


Figure 7. Village of Yorkville Park landscape schematic design (Anonymous, 2012a)

The community wanted a park that reflected the scale and context of the neighborhood, incorporated the native ecology of the surrounding region, and made connections with the circulation of local streets and a system of midblock passageways. The design strategy for the competition was to design the park to express the Victorian style of collecting. In this case, “collecting” landscapes of Ontario -pine groves, prairies, marshes, orchards, alder woods, rock outcroppings and so on -and arranging them in the pattern of the nineteenth century row houses.

The park design creates a series of linear subdivisions with contextual alignments to the building lot lines across the street and connections to mid-block passageways in the

adjoining blocks. Each linear park segment is distinct in character but related to the next, creating a park of diversity and unity. To anchor this space with an element of regional glacial geology, a large 700-ton bedrock outcrop of native Muskoka granite was taken apart along natural crevices, moved 150 miles south, and reconstructed on site. Immense yet inviting, the outcrop has a wonderful tactile surface for sitting and absorbs warmth on cool sunny days. Moveable tables and chairs next to the boulder offer a nice contrast of permanence and flexibility (Figure 8.).

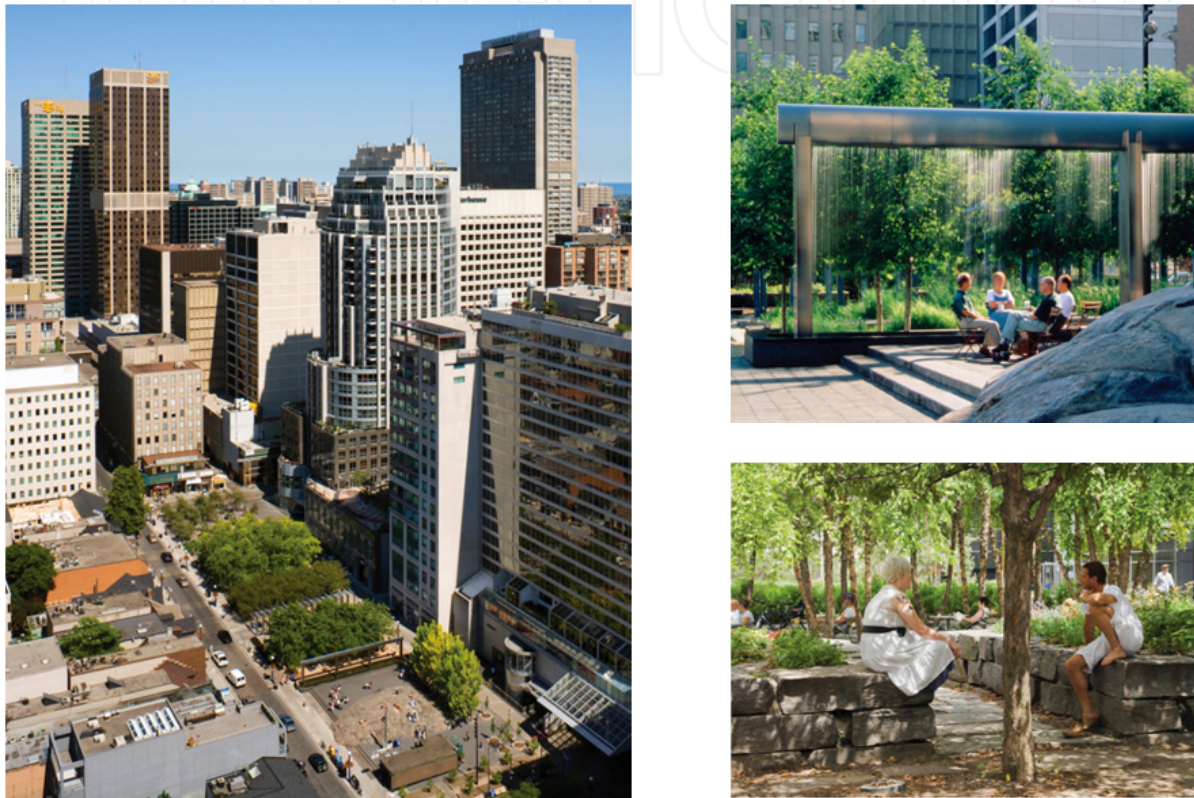


Figure 8. Village of Yorkville Park

The park has become a local landmark. While small in size, Yorkville's park has played an important role in the revitalization of the neighborhood since its completion in 1994. The neighborhood has continued its redevelopment with several new high-rise buildings rising along the edge or near the park. Recently, the park underwent some restoration work, but its original design integrity as a distillation of regional ecology, along with its role as a neighborhood connection point, remain as strong as ever. The park is owned and maintained by the City of Toronto Department of Parks, Forestry and Recreation. The Bloor-Yorkville Business Improvement Area takes an active role in the management and programming of the park (Anonymous, 2012a).

7.2.4. Downsview Park

In 1999, the Parc Downsview Park announced an International Design Competition in attempt to turn Downsview Park into an urban park, and potentially one of the largest ones

in the world, in which Bruce Mau Design, Rem Koolhaas, Oleson Worland, and Petra Blaisse submitted the winning design scheme, known as "Tree City." Parc Downsview Park has since come up with a new plan to construct commercial and residential developments instead (Anonymous, 2012b). This 320-acre federal park will provide natural and formal garden environments, offering both passive and active recreation while promoting such themes as environmental sustainability, new ecologies, and the rich heritage of the site. Contributors to this volume analyze the entries of the competition finalists and consider a range of issues raised by the competition, including landscape architecture, geography, landscape ecology, and contemporary urbanism (Czerniac, 2002).

Downsview Park is designed to support environmental, social and economic sustainability. The vision for the park is the creation of a recreational space incorporating expansive open space areas, as well as the repurposing of an inventory of historic aviation-related buildings to create a year-round setting (Figure 9.). Downsview Park is a model development demonstrating sustainable practices in its design, construction, operation and maintenance. It is intended to be a recreational, educational and cultural amenity for all Canadians (Figure 10.); a diverse, healthy and livable community for its occupants, visitors and neighbors; and an educational demonstration project of international significance. In addition to creating a unique park on the majority of the lands, portions of the property will be developed to facilitate creating and maintaining Downsview Park. More than \$20 million has been spent to date on construction, improvements to infrastructure and renovations of older buildings. The investment that Downsview Park is making in the public realm will have a significant impact well beyond its 231.5 hectares (572 acres) -job creation, increased real estate values, social and cultural engagement and numerous environmental benefits are all a direct result of the work being performed in the creation of the Park (Anonymous, 2012c).



Figure 9. Downsview Park (Anonymous, 2012b)



Figure 10. Recreational, educational and cultural amenities in the Downsview Park (Anonymous, 2012d)

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